

Arctic Research in Japan

(1) NIPR (National Institute of Polar Research):
Green Network of Excellence Program
Arctic Climate Change Research Project 2011-2016

(2) JAMSTEC:

(3) JAXA:
Arctic Research Project
Development of algorithm of satellite data
2011-2014

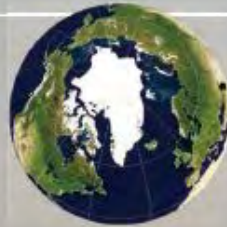
(4) Individual fund

**"GREEN Network of Excellence"
Program (GRENE Program)**

Project are...

In June 2010, the Japanese Cabinet decided upon a new strategy for growth: the "Strategy for becoming an environment and energy power through green innovation." In response to this strategy, the Council for Science and Technology Policy brought out their report "The Science and Technology Basic Plan" in December 2010, which also positioned the Arctic as one of the important issues related to climate change.

Following on, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) established the GREEN Network of Excellence (GRENE) in FY2011. Through a strategic collaboration between universities and research institutions, GRENE aims to promote both the highest level of research in the world and the training and development of human resources. In addition to its work in the Arctic Climate Research Project, GRENE is also involved in research in the environmental



Ministry of Education, Culture and Sports, Science & Technology in Japan (MEXT)
"GREEN Network of Excellence" Program (GRENE) Program

Arctic Climate Research Project
Rapid Change of the Arctic Climate System and
its Global Influences
2011-2016

GREEN Network of Excellence Program

Arctic Climate Change Research Project

Oct. 2011 - Mar. 2016

"Rapid Change of the Arctic Climate System and its Global Influences"

To the Arctic
where you can see the future of the Earth

Inter-University Research Institute
Corporation
Research Organization of Information
and Systems

**National Institute of
Polar Research**
**Arctic Environment Research
Center**

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100-8618, Japan

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Core Institute
Research Institute for Global Change (NIGGC)
Associated Institute
Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

Ministry of Education, Culture, Sports, Science and Technology (MEXT),
Core institute: NIPR, Associated institute: JAMSTEC

GRENE - Arctic Climate Change Research Project

“Rapid Change of the Arctic Climate System and its Global Influences”

Duration: 2011~2016,

NIPR: the core Institute, JAMSTEC: supporting institute,
All Japan research project with 35 universities and institutions,
and 300 researchers. Budget US\$ 8Mio (2011), 7 Mio (2012)

Strategic Research Targets



- *Understanding the mechanism of warming amplification in the Arctic*



- *Understanding the Arctic system for global climate and future change*

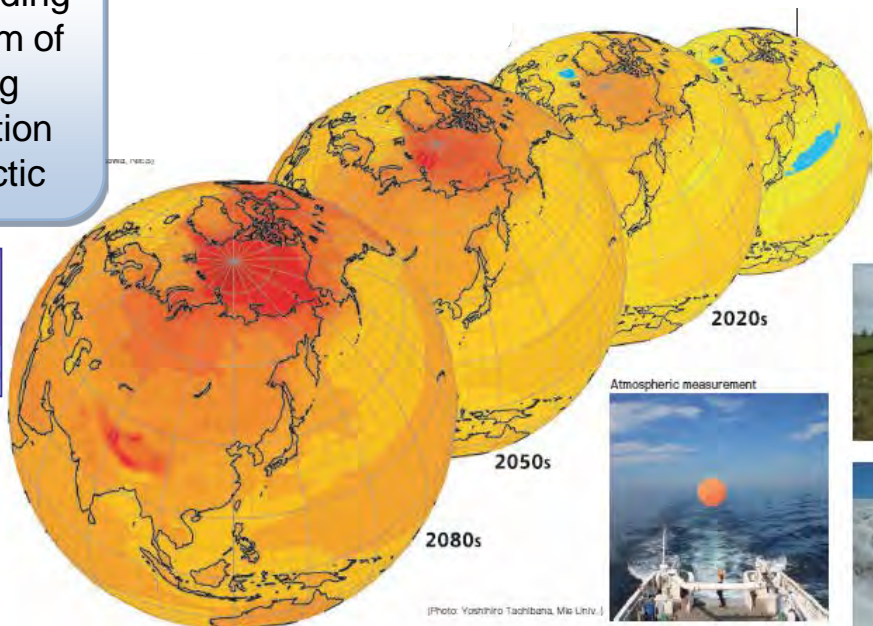


- *Evaluation of the effects of Arctic change on weather in Japan, marine ecosystems and fisheries*

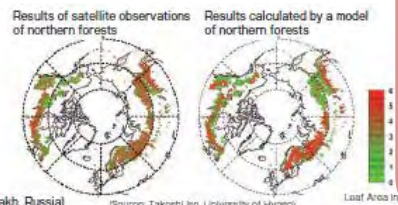


- *Prediction of sea ice distribution and Arctic sea routes*

Understanding mechanism of warming amplification in the Arctic



Understanding of Arctic climate system for global climate and future change



1990s

Plant survey (Chorkurdakh, Russia)



(Photo: Atsuko Sugimoto, Hokkaido Univ.)

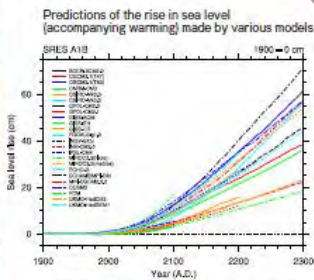


(Photo: Hiroaki Motoyama, NIFR)



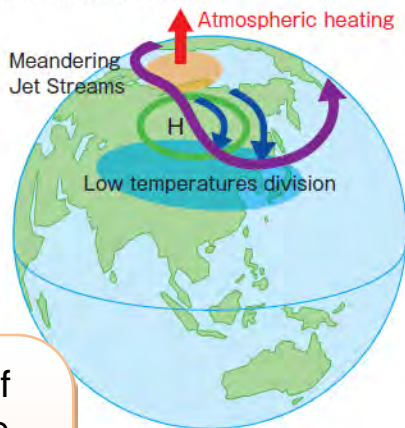
Atmospheric measurement

Predictions of the rise in sea level (accompanying warming) made by various models

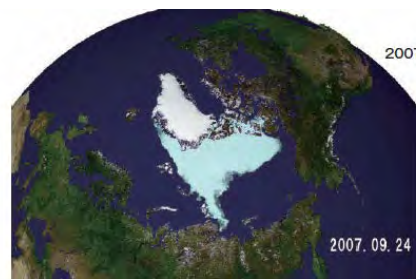
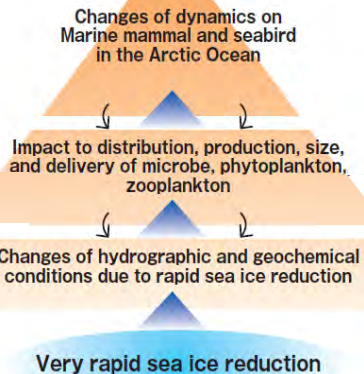


(YOSHIMIZU and ABE-KUCHI (2012) Sources of Spread in Multimodel Projections of the Greenland Ice Sheet Surface Mass Balance, J. Climate, 25, 1157-1175. DOI: 10.1175/2011.JCLI4011.1)

The impacts of Arctic changes on weather and climate in Japan



Evaluation of effects of the Arctic change on weather in Japan, marine ecosystem and fishery



Projection of sea Ice distribution responding to availability of Arctic Sea routes

GRENE- Arctic Climate Change Research Program

“Rapid Change of the Arctic Climate System and its Global Influences”

Understanding mechanism of warming amplification in the Arctic



- Improvement of coupled general circulation models based on validations of the Arctic climate reproducibility and on mechanism analyses of the Arctic climate change and variability
- The role of Arctic cryosphere in the global change
- Change in terrestrial ecosystem of pan-Arctic and its effect on climate
- Studies on greenhouse gas cycles in the Arctic and their responses to climate change
- Atmospheric studies on Arctic change and its global impacts
- Ecosystem studies of the Arctic ocean declining Sea ice
- Projection of Arctic Sea ice responding to availability of Arctic sea route
 - > Changes in the Arctic ocean and mechanisms on catastrophic reduction of Arctic sea ice cover
 - > Coordinated observational and modeling studies on the basic structure and variability of the Arctic sea ice-ocean system
 - > Sea ice prediction and construction of ice navigation support system for the Arctic sea route

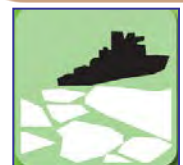
Evaluation of effects of the Arctic change on weather in Japan, marine ecosystem and fishery



Understanding of Arctic climate system for global climate and future change



Projection of sea ice distribution responding to availability of Arctic Sea routes



Strategic Research Target③

Evaluation of the impacts of Arctic change on weather and climate in Japan, marine ecosystems and fisheries



③a Evaluation of the impacts of Arctic change on weather and climate in Japan

Principal Investigator
Jinro Ukita Niigata University

Arctic teleconnection

No part in the earth's climate system that is separated from the rest. The weather and climate in Japan are not exceptions. Scorching summers and severe winters in Japan are sometimes attributed to influences from remote places. It has been known that El Nino and La Nina conditions, which are actually coupled oceanic and atmospheric phenomena centered over the tropical Pacific, impact on our weather and climate. In recent years we are beginning to understand that the Arctic would also exert influences on us by ways of changing atmospheric circulation. This is referred to as "atmospheric teleconnection". In facing

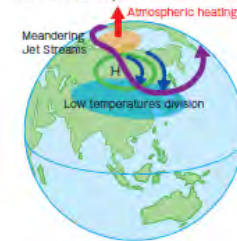
the rapid Arctic changes such as sea ice reduction, warming in the Arctic Ocean and the surrounding continents, and other accompanying changes in the hydrology and biosphere, our primary task here is to better understand physical and chemical mechanisms of this Arctic teleconnection, which results from an interplay of many different processes in clouds, aerosols, radiation and circulation. Our previous studies hint that a meandering of the westerlies jet and other circulation anomalies, for example strong Siberia and Okhotsk high pressure systems, are relevant to the Arctic teleconnection. We seek detailed explanations about the processes involved and evaluate their

impacts on the weather and climate in Japan.

Expected results

By gaining a better understanding of the underlying processes of the Arctic teleconnection to the middle latitudes, we aim at providing qualitative assessment on the impacts of the Arctic change on the weather and climate in Japan.

The impacts of Arctic changes on weather and climate in Japan



③b Evaluation of the impacts of Arctic change on marine ecosystems and fisheries

Principal Investigator
Takashi Kikuchi Japan Agency for Marine-Earth Science and Technology

Is the decrease in sea ice favourable or less favourable for the Arctic marine ecosystem and fisheries?

The decrease in the sea ice causes a change of the characteristics of the seawater in the Arctic Ocean, such as temperature, salinity, and nutrients as well as ocean currents. It also affects the marine microbes, planktons, fishes, and other mammal's lives. Marine fisheries resources such as cod, salmon and crab are no exception. So, here are questions; is the decrease in sea ice favourable or less favourable for the Arctic marine ecosystem and fisheries? How does sea ice variability, i.e., ice melting/formation, ice motion, seasonal cycle, and recent inter-annually rapid decrease, affect the Arctic Ocean environments from physical, chemical and biological points of view? To achieve the strategic research target ③ b: Evaluation of the impacts of the Arctic changes on marine ecosystem and fisheries, we initiate the following

research project.

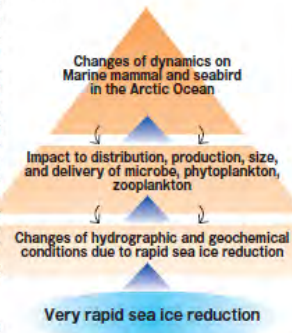
(6) Ecosystem studies on the Arctic Ocean declining sea ice

The purpose of this project is to clarify and predict the influences of sea ice reduction in the Arctic Ocean on marine ecosystem and fisheries resources. For the purposes, field observations in the Pacific side of the Arctic Ocean, satellite monitoring on sea ice and marine environments, and numerical simulations for detailed understanding on-going environmental changes and future state will be done. Not only biological but also physical and chemical processes are involved in the Arctic environmental changes caused by recent sea ice reduction. And thus, this project will pay particular attention to the linking among the multi-disciplinary studies on the Arctic Ocean, i.e., physical oceanography, geochemistry and biology.

Expected outcomes

Field measurement during the

project and analyses using historical and observational data can detect on-going changes of the Arctic Ocean environment. Important multi-disciplinary processes which cause such environmental changes are also clarified. Development of the marine ecosystem models for the Arctic Ocean can show the detailed information about on-going environmental changes and might be able to predict future changes in fisheries resources and population sizes.



Strategic Research Target④

Projection of sea ice distribution and Arctic sea routes



Principal Investigator
Koji Shimada Tokyo University of Marine Science and Technology

Linking the Pacific and Atlantic by the shortest route

Environmental change of the Arctic Ocean already exceeds the frame of a scientific problem, and attracts social attention. It is expected that reduction of sea ice area leads to use on the Arctic sea routes which can serve as the shortest distance between the Pacific Ocean and the Atlantic Ocean. Under these circumstances, understandings of the actual Arctic sea ice dynamics are absolutely essential and use of the Arctic Ocean.

The following research projects are being carried out to achieve strategic research target ④. **④a** is small text?

a. Changes in the Arctic Ocean and mechanisms of catastrophic reduction of Arctic sea ice

The reduction of Arctic Sea ice has accelerated beyond the prediction of any climate models, the mechanism of the reduction is, however, still unclear. To elucidate the mechanisms of the Arctic sea ice reduction is urgent issue to build the Arctic sea ice forecasting system. In sub-project (a), we will clarify the mechanisms on the Arctic sea ice reduction, based on in-situ and Japan Aerospace Exploration Agency's satellite observations. Through a series of joint observations with overseas Arctic research observational agencies, the GRENE Arctic Climate Change Research Project is using foreign icebreakers that are essential for in-situ observations in the Arctic Ocean. In-situ observation includes not only hydrographic observation but also the moored observation systems that can measure sea ice movement and thickness, the water temperature, salinity, and the direction/speed of ocean current under the sea ice.

b. Sea ice prediction and construction of an ice navigation support system for the Arctic sea routes

The area of navigable water is formed only during summer time when the Arctic sea ice shrinks. By early spring when shipping schedules are being planned, people need to know ice-free period in the Arctic Ocean. Since the sea ice distribution is changing at every moment, scientists are building a system to predict sea ice on a daily to monthly time scale.

c. Coordinated observational and modeling studies on the basic structure and variability of the Arctic sea ice-ocean system

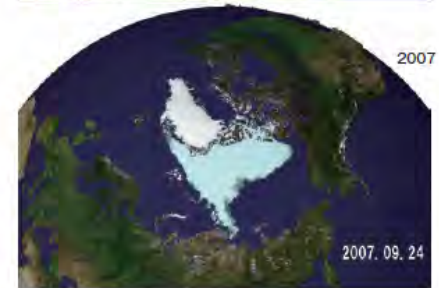
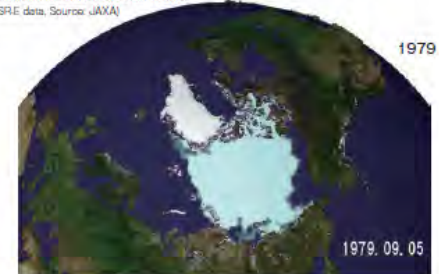
The numerical model of the Arctic Ocean is required for highly accurate sea ice forecasts. To this end, scientists

are developing a model that can reproduce the complex oceanic structure in connection with the Pacific Ocean, Atlantic Ocean and various rivers; the developments of sea ice and oceanic structures. Scientists will use this model to build a system to predict Arctic sea ice distribution over a scale that will range for a season to several decades.

Expected results

Clarifying the mechanism for the rapid reduction of sea ice and building a model for the oceanic structure of the Arctic Ocean will lead to build the forecasting system of the Arctic sea ice. This will enable people to determine the feasibility of a northern sea route.

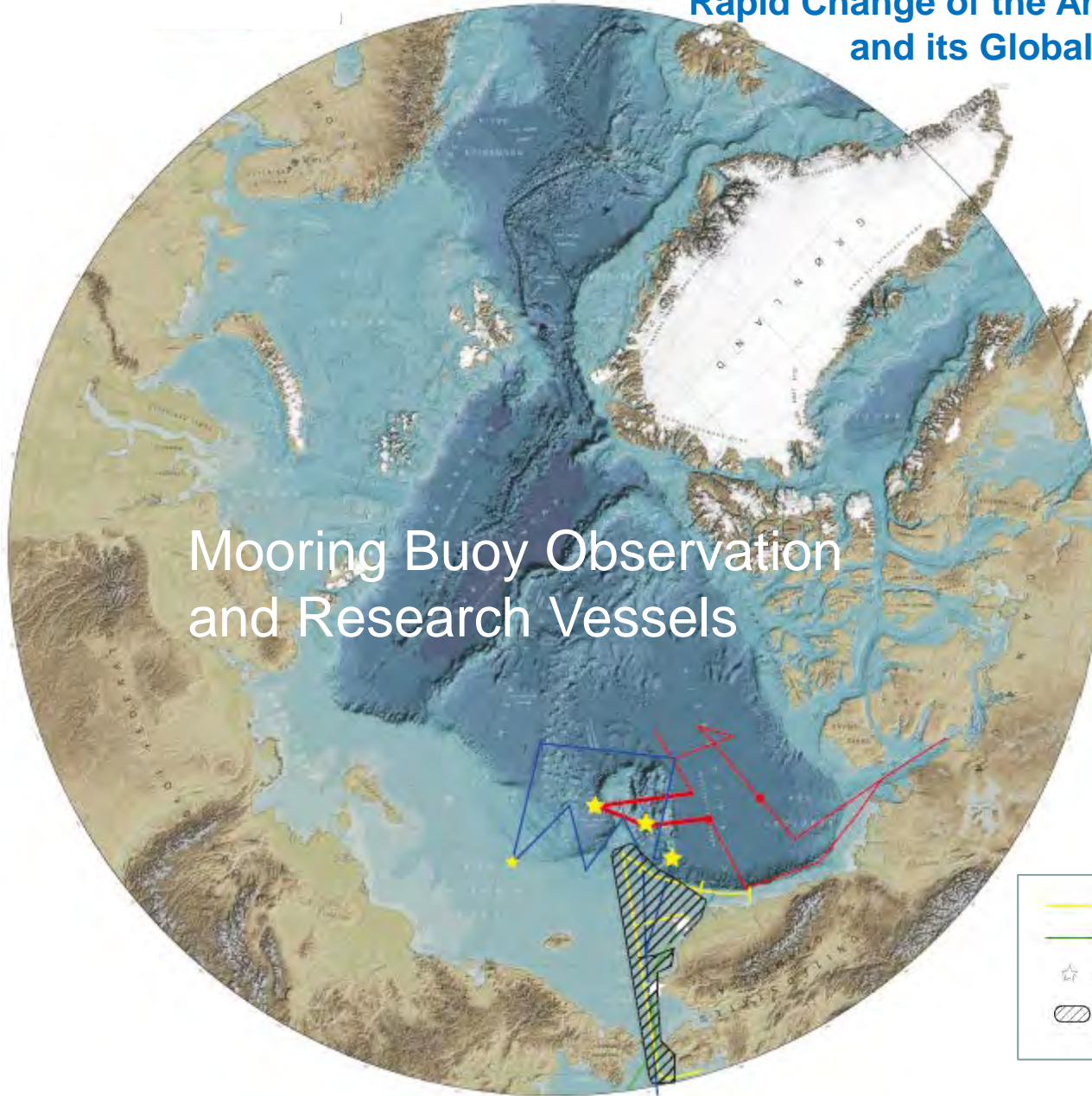
Distribution of sea ice on the day when its total area of coverage is at a minimum and Arctic Sea routes (AMSR-E data, Source: JAXA)



GRENE- Arctic Climate Change Research Program

“Rapid Change of the Arctic Climate System and its Global Influences”

Mooring Buoy Observation and Research Vessels



- LSSL (Canada)
- Araon (Korea)
- ★ Moored observation system

- R/V Mirai (JAMSTEC)
- Laurier (Canada)
- ☆ Moored observation system
- ▨ Oshoro (planned 2013, Hokkaido Univ.)

2012

Mirai (NIPR)

Louis S. St-Laurent

MMP moorings & Northwest passage: (NIPR/GRENE) ~2015

Sediment trap and Standard moorings: (JAMSTEC)

Sir Wilfrid Laurier (NIPR/GRENE)

IBRV Araon (mooring: NIPR, others: JAXA) ~2015

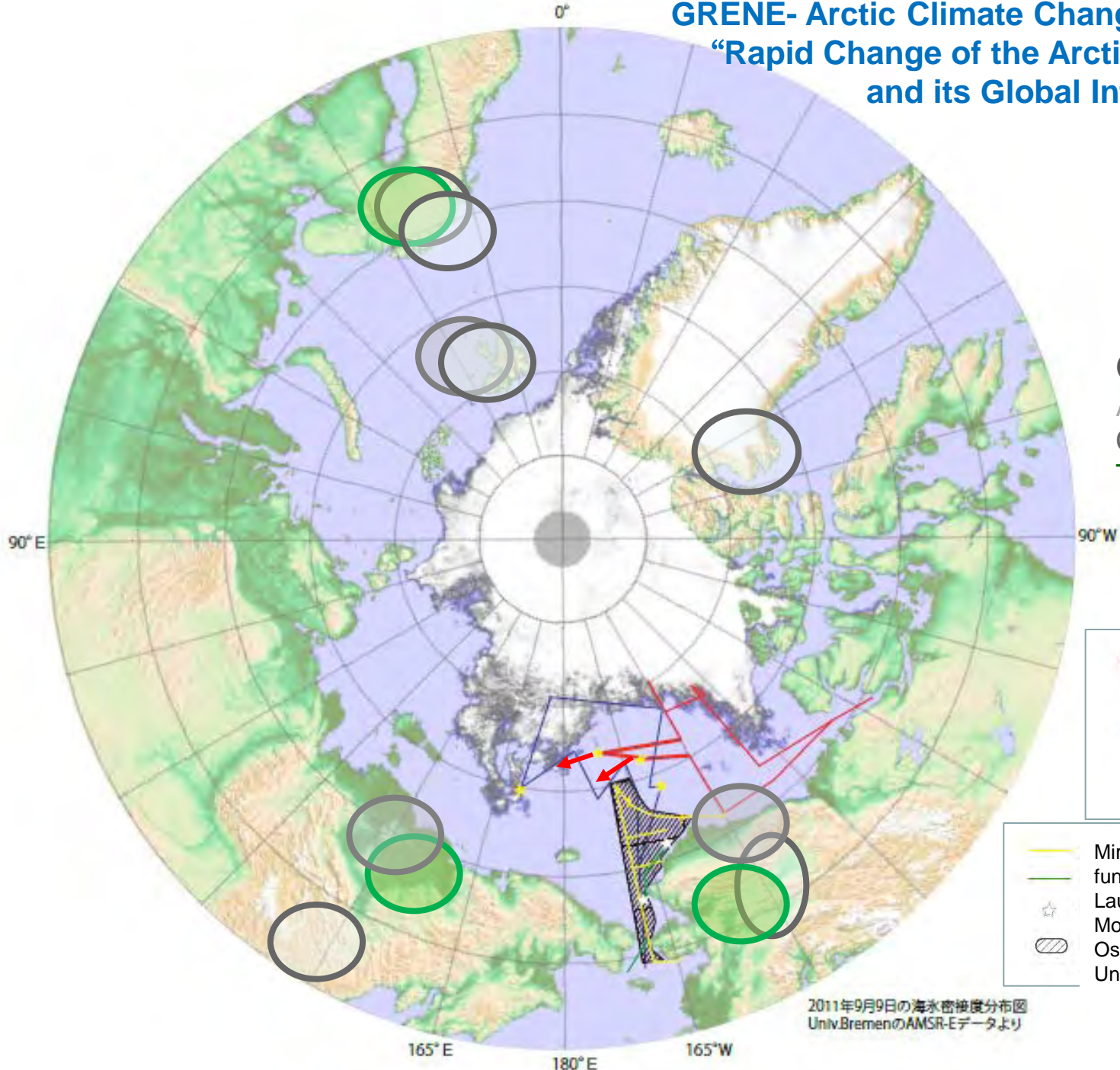
2013

Mirai (JAMSTEC)

T/S Oshoro (NIPR/GRENE & Hokkaido U) ~2015(replacement)?

GRENE- Arctic Climate Change Research Program

“Rapid Change of the Arctic Climate System and its Global Influences”



Observation sites:
 Atmosphere
 Cryosphere
 Terrestrial

- LSSL (Canada)
NIPR, JAMSTEC
- Araon (Korea) NIPR, JAXA
- ★ Moorings: NIPR

- Mirai (JAMSTEC) GRENE funded (2012)
- ☆ Laurier (Canada)
- Moored observation system
- Oshoro (planned 2013, Hokkaido Univ.)

2011年9月9日の海水密度分布図
 Univ.BremenのAMSR-Eデータより